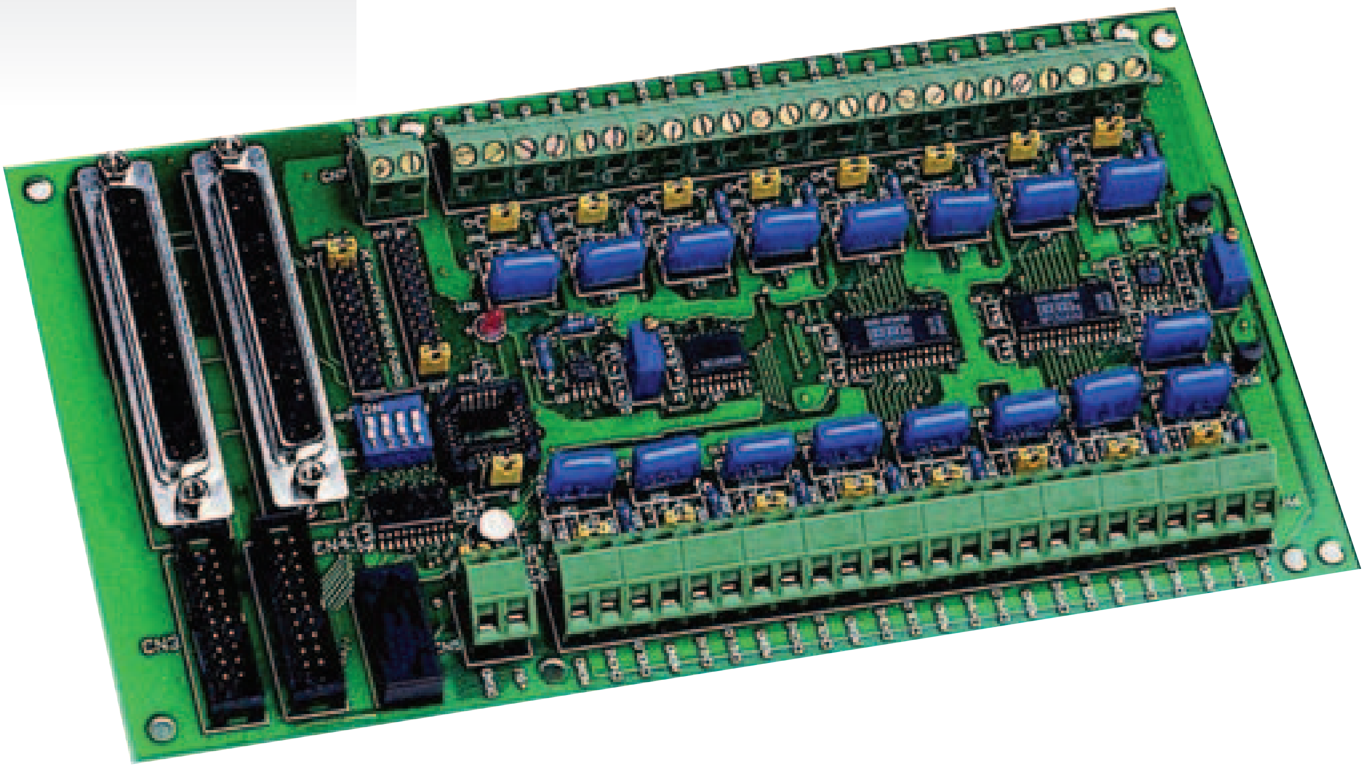
User's Guide

Shop online at

www.omega.com
e-mail: info@omega.com

ISO 9001 CERTIFIED CORPORATE QUALITY STAMFORD, CT

ISO 9002 CERTIFIED CORPORATE QUALITY MANCHESTER, UK



OME-DB-889D

16-Channel Analog Multiplexer Board

OMEGAnet® Online Service www.omega.com	Internet e-mail info@omega.com

Servicing North America:

USA: ISO 9001 Certified
One Omega Drive, P.O. Box 4047
Stamford CT 06907-0047
TEL: (203) 359-1660 FAX: (203) 359-7700
e-mail: info@omega.com

Canada:
976 Bergar
Laval (Quebec) H7L 5A1, Canada
TEL: (514) 856-6928 FAX: (514) 856-6886
e-mail: info@omega.ca

For immediate technical or application assistance:

USA and Canada:
Sales Service: 1-800-826-6342 / 1-800-TC-OMEGA®
Customer Service: 1-800-622-2378 / 1-800-622-BEST®
Engineering Service: 1-800-872-9436 / 1-800-USA-WHEN®
TELEX: 996404 EASYLINK: 62968934 CABLE: OMEGA

Mexico:
En Español: (001) 203-359-7803 e-mail: espanol@omega.com
FAX: (001) 203-359-7807 info@omega.com.mx

Servicing Europe:

Benelux:
Postbus 8034, 1180 LA Amstelveen, The Netherlands
TEL: +31 (0)20 3472121 FAX: +31 (0)20 6434643
Toll Free in Benelux: 0800 0993344
e-mail: sales@omegaeng.nl

Czech Republic:
Frystatska 184, 733 01 Karviná, Czech Republic
TEL: +420 (0)59 6311899 FAX: +420 (0)59 6311114
Toll Free: 0800-1-66342 e-mail: info@omegashop.cz

France:
11, rue Jacques Cartier, 78280 Guyancourt, France
TEL: +33 (0)1 61 37 29 00 FAX: +33 (0)1 30 57 54 27
Toll Free in France: 0800 466 342
e-mail: sales@omega.fr

Germany/Austria:
Daimlerstrasse 26, D-75392 Deckenpfronn, Germany
TEL: +49 (0)7056 9398-0 FAX: +49 (0)7056 9398-29
Toll Free in Germany: 0800 639 7678
e-mail: info@omega.de

United Kingdom: ISO 9002 Certified
One Omega Drive, River Bend Technology Centre
Northbank, Irlam, Manchester
M44 5BD United Kingdom
TEL: +44 (0)161 777 6611 FAX: +44 (0)161 777 6622
Toll Free in United Kingdom: 0800-488-488
e-mail: sales@omega.co.uk

It is the policy of OMEGA to comply with all worldwide safety and EMC/EMI regulations that apply. OMEGA is constantly pursuing certification of its products to the European New Approach Directives. OMEGA will add the CE mark to every appropriate device upon certification.

WARNING: These products are not designed for use in, and should not be used for, patient-connected applications.

OME-DB-889D Multiplexer Board

1. Function Description

The OME-DB-889D is an expansion multiplexer / amplifier board for use with OME-A-82X, OME-PCI-1800 series. Each OME-DB-889D multiplexes 16 differential analog input channels into one analog input of the DAS board. The high grade instrumentation provides software programmable gains of 0.5, 1, 5, 10, 50, 100, 500 and 1000.

Thermocouple measurements are handled easily with OME-DB-889D. The board includes cold junction sensing and compensation circuitry that provides a scaling of 24.4mV/°C. Biasing restores are includes for open thermocouples detentions of voltage measurements or 112 channels of thermocouple measurement.

1.1 Features

- Connects directly to OME-A-82X, OME-PCI-1800 series boards with D-sub 37 connectors.
- Cold-junction compensation for thermocouples and thermocouple open detection.
- Software-programmable instrumentation amplifier
- Gain of 0.5, 1, 5, 10, 50, 100, 500, 1000
- Daisy chain up to ten OME-DB-889D boards

1.2 Applications

- Energy management
- Signal conditioning
- Analog Multiplexer

1.3 Specification

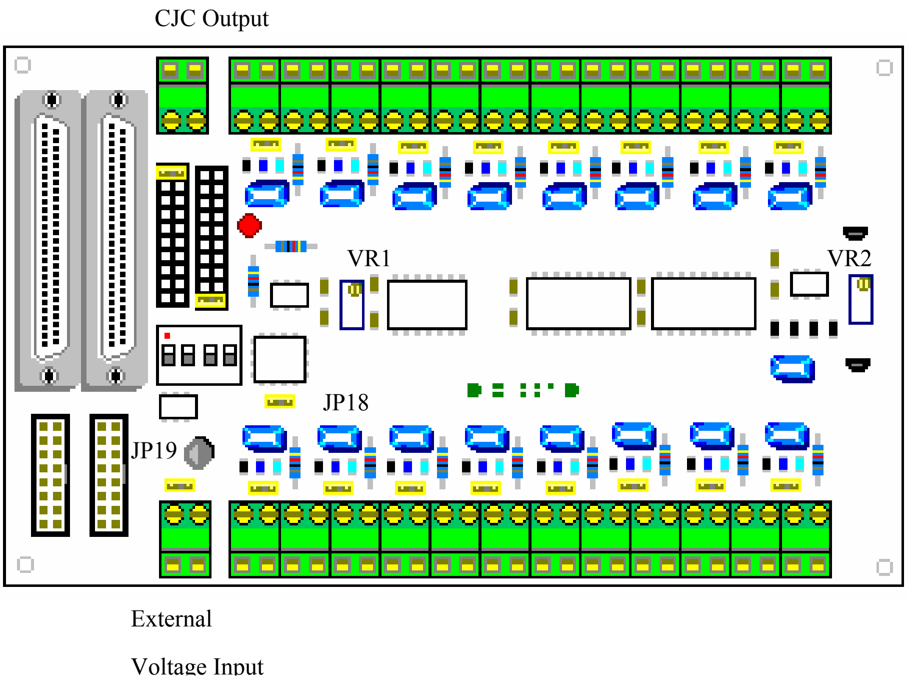
- Accepts thermocouple type : J, K, T, E, S, R, B
- Cold-junction Compensation : +24.4mV/°C , 0V at 0°C
- Overvoltage protection : ±30V Continuous
- Common mode voltage : ±10V max.
- Analog output Voltage to A/D card :±10V

Gain	Common Mode Rejection	Non linearity %of FSR	Settling Time
0.5	99dB	±0.0004	23uS
1	99dB	±0.0004	23uS
5	114dB	±0.0004	28uS
10	99dB	±0.0004	28uS
50	123dB	±0.0004	140uS
100	123dB	±0.0004	140uS
500	123dB	±0.0008	1300uS
1000	123dB	±0.0008	1300uS

- Power requirement : +5V@120mA
- Dimension :114mm X 204mm
- Operating temperature : 0~60°C
- Storage temperature : -20~80°C
- Humidity : 5% to 90% non condensing

2. Installing

2.1 Layout

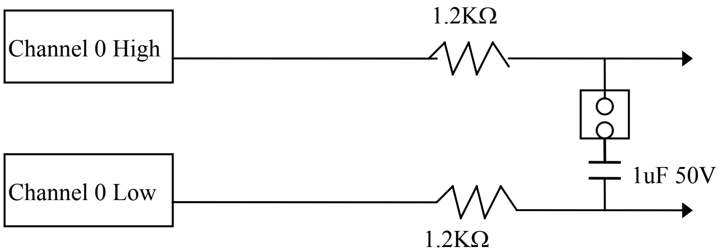


Jumper /Connector Name	Function	Note
CN1	Connect to A/D connector of OME-A-82x series	
CN2	Cascaded to another OME-DB-889D	
CN3	Connect to D/O connector of OME-A-82x series	
CN4	Cascaded to another OME-DB-889D	
CN5	External +5V power input	Select by JP19
CN6, CN8	Analog input channel 0~ channel 15	
CN7	CJC signal output connector	
JP0~JP15	Channel 0 ~ channel 15 R/C filter enable	Short : Filter Enable Open : Filter Disable
JP16	Analog output channel selection	to OME-A-82x series A/D card
JP17	CJC output channel selection	to OME-A-82x series A/D card
JP18	Gain control by on board dip switch or digital output of OME-A-82x series multi-function card	L : by dip switch R : by Digital output
JP19	Use PC's +5V or External +5V power	

2.2 Jumper setup

2.2.1 JP0 ~ JP15 Analog Input R/C Filter

The OME-DB-889D provides R/C filter with each analog input channel by jumper setting.



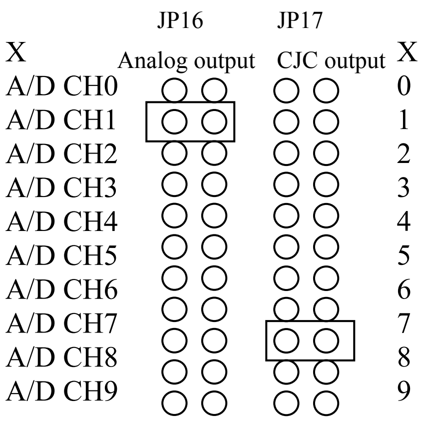


Short : with filter
Default setting

Open : Without filter

2.2.2 JP16 Analog Output Channel Jumper

The OME-DB-889D supports 10 separate jumper to select output channel, This feature permits up to 10 OME-DB-889D's be connected to a 10 channel analog input card. Place the jumper in the output channel according to the channel of the analog input card selected for that OME-DB-889D board. The following table illustrates the jumper setting of using the OME-DB-889D with the OME-A-82X series.



If none of the output channel is used, leave the jumper in position "X". If the CJC output is required for the thermocouple applications, be aware that the analog output and CJC output share the connector for the analog output and the CJC output.
Note: "X" means channels are not supported by the OME-A-82Xseries

2.2.3 JP19 Internal / External Power selection

The OME-DB-889D requires single +5V power supply. the connector CN5 are used for the external power supply connection. The OME-A-82X series multi-function card offers +5V power from the 37 pin connector , The OME-DB-889D can be directly from the PC I/O bus by connecting the OME-A-82Xseries multi-function card.

JP19



From PC's +5V Power
Default Setting

From the CN5 input External +5V power

2.2.4 JP18 Local / Remote Gain control

The OME-DB-889D provides local and remote control and the selection depends on the setting of the switch SW1.

JP18



Remote Gain Control
Default Setting

Local Gain Control

Note:
"L" Local Gain control : from OME-DB-889D on board dip switch setting
"R" Remote Gain control : from OME-A-82X series A/D card digital output control

Remote Gain Control

When the JP18 is set to "R", it means Remote Gain Control is selected and the gain is controlled by the digital signal of connector CN3 bit D4, D5, D6. The bit pattern and related gain is illustrated as:

CN3

D6	D5	D4	Gain
0	0	0	0.5
0	0	1	1
0	1	0	5
0	1	1	10
1	0	0	50
1	0	1	100
1	1	0	500
1	1	1	1000

Local Gain Control

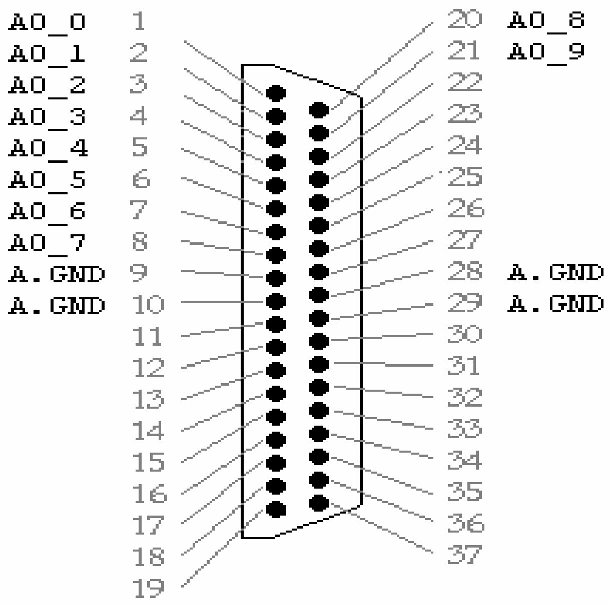
Sw1

1	2	3	4	Gain
ON	ON	ON	OFF	0.5
ON	ON	OFF	OFF	1
ON	OFF	ON	OFF	5
ON	OFF	OFF	OFF	10
OFF	ON	ON	OFF	50
OFF	ON	OFF	OFF	100
OFF	OFF	ON	OFF	500
OFF	OFF	OFF	OFF	1000

2.3 Pin Assignment

The OME-DB-889D provides two 37pin D-Sub connector & two 20-pin flat cable connector. The CN1, CN2 D-sub connector is analog output link to analog input connector of OME-A-82X series multi-function card & cascaded another OME-DB-889D. The CN3, CN4 is digital control multiplex & gain setting link to digital output connector of OME-A-82x series multi-function card .

CN1 , CN2

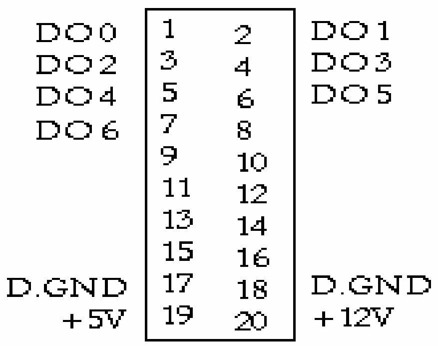


Note:

AO_n : analog output channel n

A.GND : Analog grounc

CN3 , CN4



Note

DOn : DO0~DO3 Multiplexer control bit.

DO4~DO6 Gain control bit

D.GND : Digital Ground +5V : PC's +5V +12V PC's +12V

3 Analog input & Gain setting

3.1 Input Channel Selection

The DB-990D provides 15 channel differential analog inputs. Input channel selection is controlled by the 4 bit TTL/CMOS digital data (CN3 DO0~DO3) issued by the OME-A-82x series multi-function card.

DO 3	DO 2	DO 1	DO 0	Analog input channel
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	10
1	0	1	1	11
1	1	0	0	12
1	1	0	1	13
1	1	1	0	14
1	1	1	1	15

3.2 Gain Setting

The high grade instrumentation provides software programmable gains or switch selectable gain of 0.5 1, 5, 10, 50, 100, 500, 1000.

Software Setting : JP18 should be place on “R”
Switch Setting : JP18 should be place on “L”

Software Setting (Remote control)			Switch Setting (Local Control)			Gain	
DO 6	DO 5	DO 4	SW1-3	SW1-2	SW1-1		
0	0	0	ON	ON	ON	0.5	
0	0	1	ON	ON	OFF	1	
0	1	0	ON	OFF	ON	5	
0	1	1	ON	OFF	OFF	10	
1	0	0	OFF	ON	ON	50	
1	0	1	OFF	ON	OFF	100	
1	1	0	OFF	OFF	ON	500	
1	1	1	OFF	OFF	OFF	1000	

3.3. The Thermocouple Input

The OME-DB-889D can accept thermocouple sensor to measure temperature. The OME-DB-889D should be set to different gain value if use different thermocouple type.

If you are usingOME-A-82XPGL series multi-function bard to linked OME-DB-889D you have got the gain as:

Gain = OME-A-82X Gain X OME-DB-889D Gain

OME-A821PGL Gain = 1 , 2 , 4 , 8 OME-DB-889D Gain = 0.5 , 1 , 5 , 10 , 50 , 100 , 1000

Examples

OME-A-82XPG L Series		OME-DB -889D	Gain
1	X	1	1
2	X	1	2
4	X	1	4
1	X	5	5
1	X	10	10
1	X	100	100
2	X	100	200
4	X	100	400
1	X	500	500
1	X	1000	1000
:	X	:	:
:	X	:	:

Thermocouple type & suitable gain

TYPE E	TYPE J	TYPE K	TYPE R	TYPE S	TYPE T
-270°C to 1000°C	-210°C to 760	-270°C to 1370°C	0°C to 1760°C	0°C to 1760°C	-270°C to 400°C
-9.835mV to 76.358mV	-8.096mV to 42.922mV	-6.458mV to 54.807mV	0mV to 21.006mV	0mV to 18.612mV	-6.258mV to 20.869mV
Gain=50	Gain=100	Gain=50	Gain=200	Gain=200	Gain=200

3.3.1 Voltage - TO - Temperature Conversion

The temperature-versus-voltage relationship of a the thermocouple is not linear. You can reference the thermocouple reference tables to get V to T values. Or use temperature conversion equation to get V to T values.

Temperature Conversion Equation:

T = a0 + a1 x + a2 x^2 + a3 x^3 + a4 x^4 + …….. + a**n** x^**n**
where
T = Temperature
x = Thermocouple Voltage
a = Polynomial coefficients unique to each thermocouple
n = Maximum order of the polynomial

	TYPE E	TYPE J	TYPE K	TYPE R	TYPE S	TYPE T
a0	-100°C to 1000°C	0°C to 760°C	0°C to 1370°C	0°C to 1000°C	0°C to 1750°C	-160°C to 400°C
a1	0.104967248	-0.048868252	0.226584602	0.263632917	0.927763167	0.100860910
a2	17189.45282	19873.14503	24152.10900	179075.491	169526.5150	25727.94369
a3	-282639.0850	-218614.5353	67233.4248	-48840341.37	-31568363.94	-767345.8295
a4	12695339.5	11569199.78	2210340.682	1.90002E+10	8990730663	78025595.81
a5	-448703084.6	-264917531.4	-860963914.9	-4.82704E+12	-1.63565E+12	-9247486589
a6	1.10866E+10	2018441314	4.835606E+10	7.62091E+14	1.88027E+14	6.97688E+11
a7	-1.76807E+11		-1.18452E+12	-7.20026E+16	-1.37241E+16	-2.66192E+13
a8	1.71842E+12		1.38690E+13	3.71496E+18	6.17501E+17	3.94078E+14
a9	-9.19278E+12		-6.33708E+13	-8.03104E+19	-1.56105E+19	
	2.06132E+13				1.69535E+20	

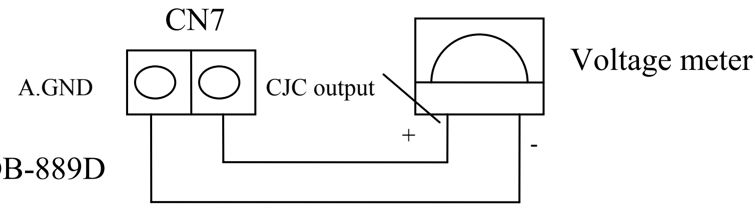
Note:
1. The thermocouple range of this table is this equation limited.
2. Other detail data please reference thermocouple data book.

3.3 CJC Output

The OME-DB-889D provides Cold-Junction Compensation (CJC) for the thermocouple applications. If the CJC is required, place the JP17 in the position of the channel to be used as a CJC reference. If the CJC is not required, Place the JP17 in the position “X”.

CJC has output on connector CN7. Using a voltage meter measures CN7 which exists a voltage related to the OME-DB-889D board temperature. The CJC voltage transfers to temperature with formula:

$$T(°C) = V*1000/24.4$$



V: Voltage of CN7

T: Temperature of OME-DB-889D

Example: (Turbo C)
Multi-Function Card: OME-A-822PGL
The OME-DB-889D JP17 placed on “7”.

```
/*====================Example Program ===================*/
#include <stdio.h>
#include “A822.h>

main(void)
{int ad_channel , gain , trigger_mode, poll_data ;
float temp;
A822_Initialize(0,0x220, -1, -1);
                        /* Initials OME-A-822PGL Ref. OME-A-822PGH/L Software
                        Manual */
ad_channel=7;
gain=0;
trigger_mode=1;

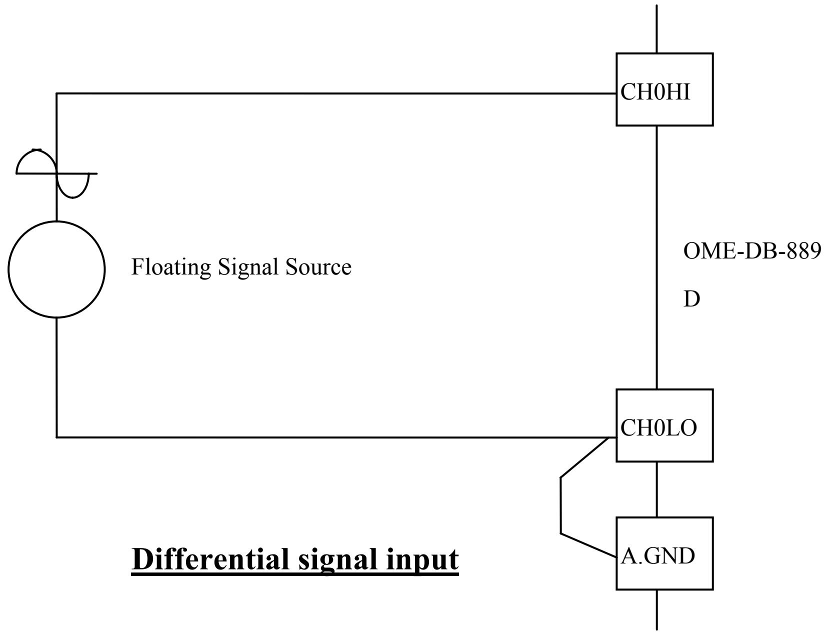
for(;;)
     {
      A822_AD_SetChGainMode(ad_channel , gain , trigger_mode );
      /* SettingOME-A-822 A/D channel =7 , Gain=1 , Trigger mode = Software
trigger */
      poll_data=A822_AD_PollingVar();
      temp=(float)(((poll_data-2048)*5/2048)*1000/24.4);
      prinf(“ Temperature = %4.1f °C \n”, temp);
      }
}
```

4 Signal Connection

The OME-DB-889D can multiplex up to 16 channel differential inputs. Input channel selection is controlled by a CN3 D4~ D6 digital output by OME-A-82x series multi-function card.

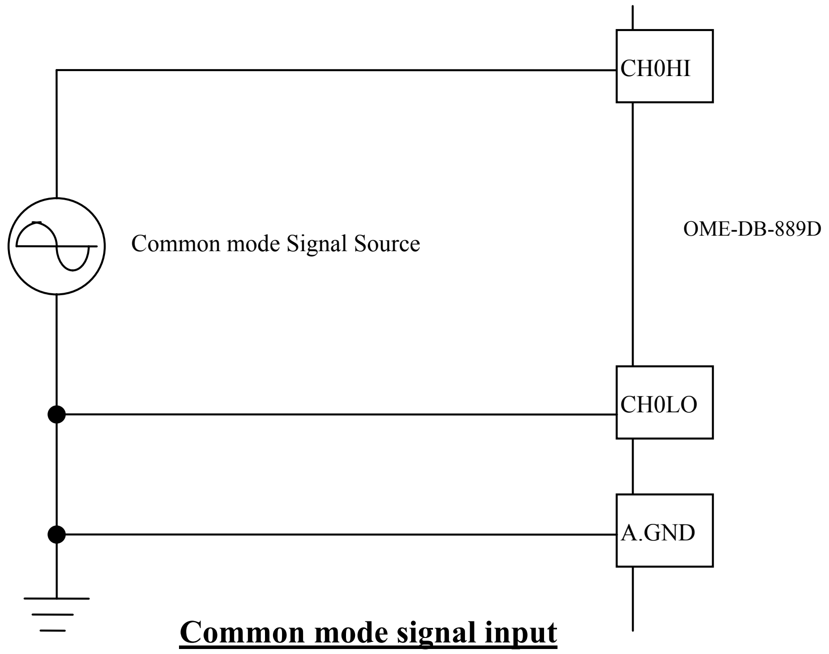
4.1 Floating Signal Connection

The OME-DB-889D has only differential input channels, each input channel should be two signal wires. The input should be connected as:



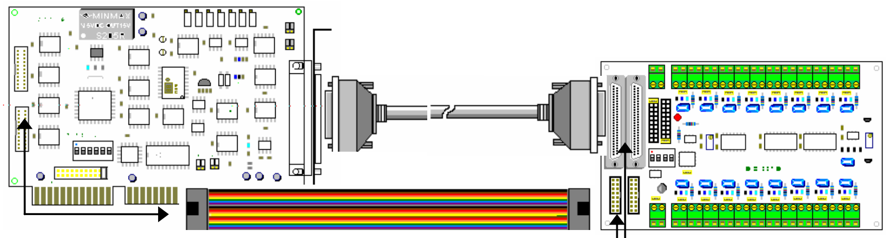
4.2 Non-Floating Signal Source

Some the signal source has one side connect to a local ground. The signal ground with OME-DB-889D ground will not be same voltage level. The input should be show as:



Common mode signal input

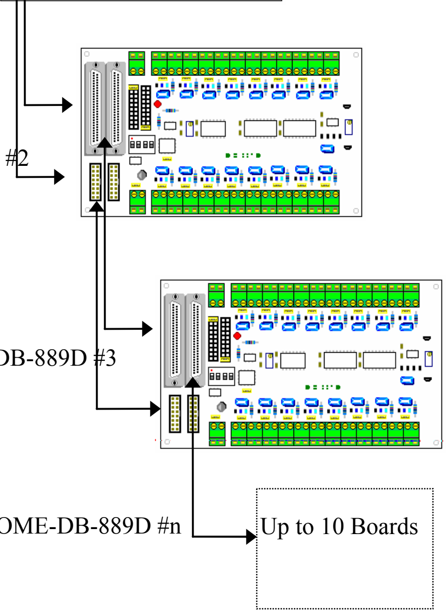
4.3 Cascading OME-DB-889D



OME-A-82X series A/D card

1. A821PGH/L
2. OME-A-822PGH/L
3. OME-A-823PGH/L
4. OME-A-826PGH/L
5. PCI-1800PGH/L

Note: PCI-1802 should be via DB-1825 connect to OME-DB-889D

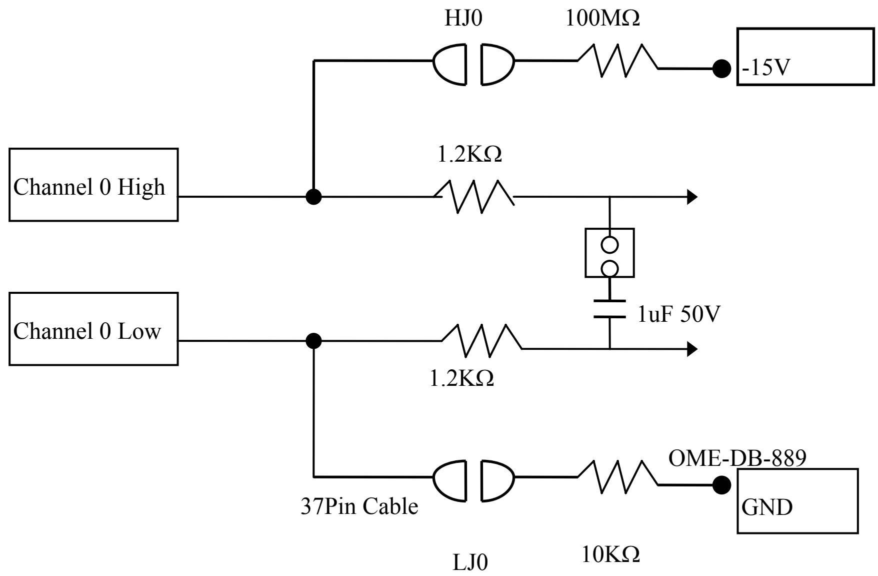


OME-A-82X series	OME-DB-889D	JP16
A/D Channel 0	OME-DB-889D #1	0
A/D Channel 1	OME-DB-889D #2	1
A/D Channel 2	OME-DB-889D #3	2
A/D Channel 3	OME-DB-889D #4	3
A/D Channel n	OME-DB-889D #n	n
A/D Channel 9	OME-DB-889D #10	9

Note: Each OME-DB-889D JP17 place on "X"

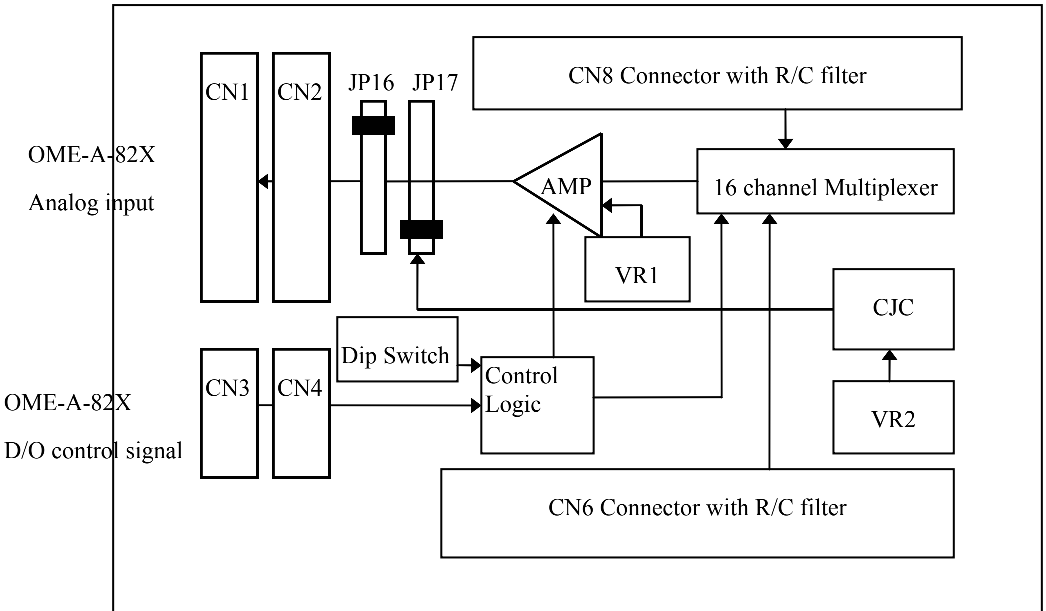
4.4 Open Thermocouple Detection

The OME-DB-889D provides open thermocouple detection through a resistor circuitry. These resisters are normally not connected. The user can find on the back of the board has two solder gaps for each input channel. If you short the solder gaps, the open thermocouple detection is enabled.



Note:
If a thermocouple opens, the bias resistor will slowly pull the input voltage to -10V then user can use a simple application program to detect the voltage change.

4.5 Block Diagram



OME-DB-889D Block Diagram

CN1: connect to OME-A-82x series multi-function card
CN2: connect to CN1 of another OME-DB-889D
CN3: connect to OME-A-82x series digital output
CN4: connect to CN3 of another OME-DB-889D
AMP: programmable gain amplifier (PGA)
VR1: PGA off-set adjustment.
VR2: CJC gain adjustment

5 Programming

The OME-A-82x series multi-function card can support up to 160 channels by cascading 10 OME-DB-889D’s without complex programming.

5.1 Using OME-A-822PGL

This section will use OME-A-822PGL to link OME-DB-889D.
The major steps are listed below:
Step 1: Hardware installing.

1. Turn off power of computer.
2. Plug in OME-A-822PGL then connect 37 pin cable & 20 pin flat cables to CN1 and CN3 of OME-DB-889D.
3. Setup OME-DB-889D (Ref. Jumper setting section of OME-DB-889D. The example program uses default setup)
4. Connect your signal wiring.
5. Turn on your computer power.
6. Installing OME-A-822PGL C library.
7. Now you are ready to programming.

Step 2: Software programming (C Language)

1. Using OME-A-822 library function to initial OME-A-822PGL
2. Setup OME-A-822PGL: Bipolar mode , Gain = 1 , Analog input channel = 0 , Trigger mode = Polling mode.
3. Send digital output of OME-A-822PGL data to control OME-DB-889D

D0~D3: OME-DB-889D channel selection, D4~D6: OME-DB-889D Gain setting

4. Reading OME-A-822PGL analog input data
5. Conversion data to voltage or temperature

Note:
The OME-A-82X series programming steps are same as those for the OME-A-822PGL

5.3 Example Program

DEMO_01.C

```
/* ============== Using OME-A-822 / connect one OME-DB-889D
=================*/
#include <stdio.h>
#include "A822.h"

main(void)
{int data1,data2;
float vol1,vol2;
A822_Initialize(0,0x220,-1,-1);
 /*   OME-A-822 Base address in 0x220   ref. OME-A-822 Software manual */

for(;;)
    {
/*===============reading OME-DB-889D Channel 0 , Gain =1
=============*/
     A822_AD_SetChGainMode(0,0,1);
                         /* Setup OME-A-822 A/D channel 0, Gain = 1 , Polling mode
                        */
     A822_DO(0x0010);
                        /* Send D/O data to OME-DB-889D , Channel 0, Gain=1    */
     delay(10);             /* delay about 43u sec . Ref. Page 3 Settling time */
     data1=A822_AD_PollingVar();
                        /* Reading OME-A-822 A/D data */
     vol1=(float)((data1-2048)*5/2048);
     printf("OME-DB-889D channel 0= %6.4f V\n",vol1);

/*===========reading OME-DB-889D Channel 1 , Gain=10
===============*/
     A822_AD_SetChGainMode(0,0,1);
                         /* Setup OME-A-822 A/D channel 0, Gain = 1 , Polling mode
                        */
```

```
    A822_DO(0x0021);
                    /* Send D/O data to OME-DB-889D , Channel 1, Gain=10    */
    delay(10);         /* delay about 43u sec , Ref. Page 3 Setting time*/
    data2=A822_AD_PollingVar();
                    /* Reading OME-A-822 A/D data */
    vol2=(float)((data2-2048)*0.5/2048);
    printf("OME-DB-889D channel 1= %6.4f V\n",vol2);
}
}
```

6. Calibration

The OME-DB-889D is calibrated to its best of operation. For environment subjected to large vibrations, recalibration is recommended. Before calibrating the OME-DB-889D, user should consider having the following available:

- One 6 digital voltage meter
- One temperature meter
- One OME-A-82x series multifunction card

6.1 Calibration VR Description

There are two VRs on the OME-DB-889D.

VR Num.	Description
VR1	Amplifier Offset adjustment
VR2	CJC Gain adjustment

6.2 Calibration Steps

1. Turn off computer power.
2. Connect OME-A-822PGL (Or any OME-A-82x series multi-function card) to OME-DB-889D.
3. Setup OME-DB-889D to default setting
4. Short CH0HI to CH0LO to A.GND of DB889D.
5. Connect probe of voltage meter to CN7 (CJC output: + , A.GND : -).
6. Turn on computer power
7. Wait about 5 minute (warn up).
8. Run Calibration program of OME-DB-889D.
9. Close the probe of temperature meter to OME-DB-889D them reading temperature value.
10. Adjust VR1 until the screen value = 0;
11. Adjust VR2 until voltage meter reading value = temperature value X 2.44mV

WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear are not warranted, including but not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by it will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESS OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive, and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and, additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

OMEGA is a registered trademark of OMEGA ENGINEERING, INC.

M4019/1103